

CLAIMS

1 1. A pixel comprising:

2 a) a substrate having a photodiode, said photodiode having a light
3 receiving area;

4 b) a color filter array (CFA) material of a first color disposed above said
5 substrate, said pixel having a first relative responsivity; and

6 c) a light shield disposed above the substrate, said light shield forming
7 an aperture, said aperture having an area substantially equal to the light
8 receiving area adjusted by a reduction factor, said reduction factor being a result
9 of an arithmetic operation between the first relative responsivity and a second
10 relative responsivity associated with a second pixel of a second color.

1 2. The pixel of claim 1 wherein the reduction factor is the result of the
2 first relative responsivity divided by the second relative responsivity.

1 3. The pixel of claim 1 wherein the light shield includes a metal layer.

1 4. The pixel of claim 1 wherein the light shield includes an opaque
2 material.

1 5. The pixel of claim 4 wherein the opaque material is a dielectric
2 material.

1 6. The pixel of claim 5 wherein the dielectric material includes a
2 silicon dioxide.

1 7. The pixel of claim 1 wherein the pixel is a green pixel and the
2 second pixel is a blue pixel.

1 8. The pixel of claim 1 wherein the pixel is a red pixel and the second
2 pixel is a blue pixel.

1 9. A method comprising the steps of:
2 a) determining a relative responsivity (S_1) for a pixel of a first color;
3 b) determining a relative responsivity (S_2) for a pixel of a second color;
4 c) determining whether the relative responsivity (S_1) for the first pixel
5 is more than the relative responsivity (S_2) of the second pixel;

6 if yes, forming a mask opening above the first pixel, said mask
7 opening having an area substantially equal to the light receiving area
8 adjusted by a reduction factor, said reduction factor being a result of an
9 arithmetic operation between the relative responsivity of the first pixel

10 and the relative responsivity of the second pixel; and forming a mask
11 opening above the second pixel, said mask opening having an area
12 substantially equal to the light receiving area;

13 else,

14 forming a mask opening above the first pixel, said mask
15 opening having an area substantially equal to the light receiving
16 area; and

17 forming a mask opening above the second pixel, said mask
18 opening having an area substantially equal to the light receiving
19 area adjusted by a reduction factor, said reduction factor being a
20 result of an arithmetic operation between the relative responsivity
21 for a second pixel and the relative responsivity of the first pixel.

1 10. The method of claim 9 wherein the light receiving area is
2 multiplied by the reduction factor.

1 11. The method of claim 9 wherein the arithmetic operation is a
2 division operation.

1 12. A method to pattern an array comprising the steps of:

- 2 a) determining a relative responsivity (S_1) for pixels of a first color;
- 3 b) determining a relative responsivity (S_2) for pixels of a second color;

4 c) determining a relative responsivity (S_3) for pixels of a third color;
5 d) determining whether the relative responsivity (S_1) for pixels of the
6 first color is lower than the relative responsivity (S_2) of pixels of the second color
7 and the relative responsivity (S_3) of pixels of a third color;

8 e) if yes,

9 forming a mask opening above the pixels of the first color,
10 said mask opening having an area substantially equal to the
11 predetermined light receiving area;

12 forming a mask opening above the pixels of the second color,
13 said mask opening having an area substantially equal to the
14 predetermined light receiving area adjusted by a reduction factor,
15 said reduction factor being a result of an arithmetic operation
16 between S_1 and S_2 ; and

17 forming a mask opening above the pixels of a third color, said
18 mask opening having an area substantially equal to the
19 predetermined light receiving area adjusted by a reduction factor,
20 said reduction factor being a result of an arithmetic operation
21 between S_1 and S_3 .

1 13. The method of claim 12 wherein the mask opening formed above
2 the pixels of the second color has an area substantially equal to the
3 predetermined light receiving area multiplied by (S_1/S_2); and the mask opening
4 formed above the pixels of a third color has an area substantially equal to the
5 predetermined light receiving area multiplied by (S_1/S_3).

1 14. The method of claim 12 further comprising the steps of:

2 a) determining whether the relative responsivity (S_2) for pixels of the
3 second color is less than the relative responsivity (S_1) of pixels of a first color and
4 the relative responsivity (S_3) of pixels of a third color;

5 b) if yes,

6 forming a mask opening above the pixels of the second color,
7 said mask opening having an area substantially equal to the
8 predetermined light receiving area;

9 forming a mask opening above the pixels of the first color,
10 said mask opening having an area substantially equal to the
11 predetermined light receiving area adjusted by a reduction factor,
12 said reduction factor being a result of an arithmetic operation
13 between S_2 and S_1 ; and

14 forming a mask opening above the pixels of a third color, said
15 mask opening having an area substantially equal to the
16 predetermined light receiving area adjusted by a reduction factor,
17 said reduction factor being a result of an arithmetic operation
18 between S_2 and S_3 .

1 15. The method of claim 12 wherein the mask opening formed above
2 the pixels of the second color has an area substantially equal to the
3 predetermined light receiving area multiplied by (S_2/S_1); and the mask opening
4 formed above the pixels of a third color has an area substantially equal to the
5 predetermined light receiving area multiplied by (S_2/S_3).

1 16. The method of claim 12 further comprising the steps of:

2 a) determining whether the relative responsivity (S_3) for pixels of a
3 third color less than the relative responsivity (S_1) for pixels of a first color and
4 the relative responsivity (S_2) for pixels of a second color;

5 b) if yes,

6 forming a mask opening above the pixels of a third color, said
7 mask opening having an area substantially equal to the
8 predetermined light receiving area;

9 forming a mask opening above the pixels of a first color, said
10 mask opening having an area substantially equal to the
11 predetermined light receiving area adjusted by a reduction factor,
12 said reduction factor being a result of an arithmetic operation
13 between S_3 and S_1 ; and

14 forming a mask opening above the pixels of a second color,
15 said mask opening having an area substantially equal to the
16 predetermined light receiving area adjusted by a reduction factor,
17 said reduction factor being a result of an arithmetic operation
18 between S_3 and S_2 .

1 17. The method of claim 12 wherein the mask opening formed above
2 the pixels of the second color has an area substantially equal to the
3 predetermined light receiving area multiplied by (S_3/S_1); and the mask opening
4 formed above the pixels of a third color has an area substantially equal to the
5 predetermined light receiving area multiplied by (S_3/S_2).

1 18. The method of claim 12 wherein the step of determining the
2 relative responsivity (S_1) for pixels of a first color includes the steps of:

- 3 a) determining an input photodiode responsivity;
- 4 b) determining an input color filter array transmittance for the first
5 color;
- 6 c) determining an input IR blocking filter characteristic;
- 7 d) computing a net response by multiplying the input photodiode
8 responsivity, the input color filter array transmittance for the first color, and the
9 input IR blocking filter characteristics;
- 10 e) determining an input light source spectral characteristic; and
- 11 f) convolving the net response and the light source spectral
12 characteristics to generate the relative responsivity (S_1) for the first color.

1 19. The method of claim 12 wherein the step of determining the
2 relative responsivity (S_2) for pixels of a second color includes the steps of:

- 3 a) determining an input photodiode responsivity;
- 4 b) determining an input color filter array transmittance for the second
5 color;
- 6 c) determining an input IR blocking filter characteristic;

7 d) computing a net response by multiplying the input photodiode
8 responsivity, the input color filter array transmittance for the second color, and
9 the input IR blocking filter characteristics;

10 e) determining an input light source spectral characteristic; and

11 f) convolving the net response and the light source spectral
12 characteristics to generate a relative responsivity (S_2) for the second color.

1 20. The method of claim 12 wherein the step of determining the
2 relative responsivity (S_3) for pixels of a third color includes the steps of:

3 a) determining an input photodiode responsivity;

4 b) determining an input color filter array transmittance for the third
5 color;

6 c) determining an input IR blocking filter characteristic;

7 d) computing a net response by multiplying the input photodiode
8 responsivity, the input color filter array transmittance for the third color, and the
9 input IR blocking filter characteristics;

10 e) determining an input light source spectral characteristic; and

11 f) convolving the net response and the light source spectral
12 characteristics to generate a relative responsivity (S_3) for the third color.

1 21. The method of claim 12 wherein the first color is red, the second
2 color is green and the third color is blue.

1 22. A method for manufacturing an improved pixel cell that employs a
2 first metal layer as a light shield comprising the steps of:

3 a) forming a substrate having active devices, said active devices
4 including a photodiode;

5 b) depositing a dielectric layer on the substrate;

6 c) performing via lithography and etch on the dielectric layer;

7 d) depositing a metal in the via;

8 e) polishing the metal;

9 f) depositing a metal layer on the dielectric layer; and

10 g) performing lithography and etch on the metal layer by employing a
11 metal mask, said metal mask having a plurality of openings; wherein the mask
12 opening above pixels of a first color having a lowest responsivity is equal to the
13 area of the predetermined light receiving area; wherein the mask opening above
14 pixels of a second color having a responsivity greater than the responsivity of
15 pixels of the first color is equal to the predetermined light receiving area
16 multiplied by S_1 divided by S_2 where S_1 is the relative responsivity of the first
17 color and S_2 is the relative responsivity of the second color; and

18 wherein the mask openings above the pixels of a third color having a
19 responsivity greater than the responsivity of pixels of the second color is equal to

- 20 the predetermined light receiving area multiplied by S_1 divided by S_3 where S_3 is
21 the relative responsivity of the third color.

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